Space Weather Technical Forecast

Issued on Monday, 15 May 2023 at 12:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance or Slight Chance of R1/R2 radio blackouts throughout. Slight chance (10%) of a G1/Minor Geomagnetic Storm late Day 1 or Day 2.
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours, with the largest flare, a longevity C2.9 flare observed 15/0800 UTC, which appears to have originated from around the southeast limb. There are currently six numbered sunspot regions on the visible disc. AR3305 is currently the largest and most complex group on the disc, although it has not yet produced any notable flares. All remaining sunspot groups are relatively small and stable. AR3296, AR3294 and AR3297 have all now rotated off the visible disc around the western limb. A small filament lift-off was observed in the northwest quadrant early on the 15th, which produced a very faint CME. This is yet to be analysed for any possible Earth-directed component. Otherwise, no CMEs of significance were observed in the 24 hour period.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, slowly increased to elevated levels at the start of the period, with a peak of 545km/s at 14/2016UTC, before a steady declining to the current slightly elevated levels, near 460km/s. The interplanetary magnetic field (IMF) has mostly been weak around 5-8nT, but briefly peaked at 9nT. The north-south component was mostly weak and co-aligned with Earth's 15nT field, with the notable exception of 14/1434-2016UTC during which time the field was southwards orientated with a nadir of -8nT. Density has been below average throughout. The phi angle was mostly positive (away from the Sun), with a period of negative (towards the sun) phi angle 14/1511-2011UTC. The net result of the above solar wind measures was mostly Quiet (Kp0-2) to Unsettled (Kp3) geomagnetic activity.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as measured at GOES16, remained at Background level through the period. High energy electron flux (greater than 2MeV), as measured at GOES16, ranged from Moderate to Normal Background levels, with a peak of 204pfu observed at 14/1620UTC. The 24-hour integrated fluence has been well below Active levels and steadily declining. At 15/0001UTC, 3.32e6 integrated pfu was recorded.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low, but with a chance of Moderate levels on Day 1 (15 May) associated with departed region AR3296, beyond the northwestern limb and perhaps on Day 4 (18 May) as AR3305 rotates into a more geoeffective position. Else tentatively falling, with no major returning regions expected.

Solar Wind / Geomagnetic Activity: Geomagnetic conditions are expected to remain largely Quiet (Kp0-2) to Unsettled (Kp3). On Days 1-2 (15-16 May) there is a slight chance of glancing blows from CME events that left the Sun 11-13 May producing minor effects at Earth and a slight chance of a G1/Minor Geomagnetic storm interval. However, misses are considered more likely with no observable effects. Solar winds are expected to remain at, or just above, slightly

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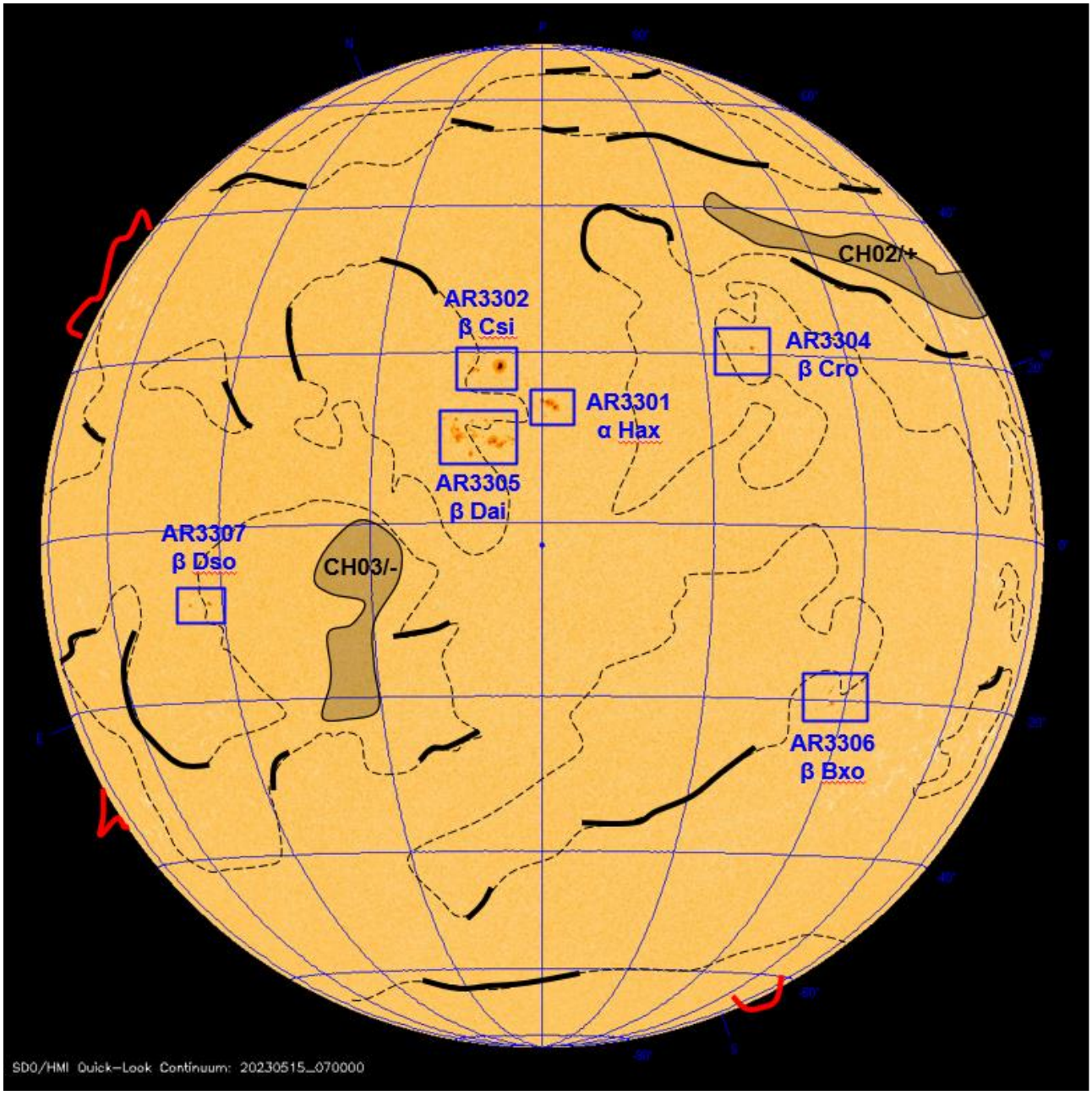
elevated levels.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux carries a daily slight chance of S1, decreasing through the period. High energy (greater than 2MeV) electron flux is expected to persist at Normal Background to Moderate levels. The associated 24-hour fluence is forecast to persist below the Active threshold.

Figure 1. Solar Analysis Valid 15/0700UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Up to three narrow glancing blows from CMEs feature in a minority of MOSWOC Enlil ensemble members from events that occurred 11-13 May. As a result, there is a slight chance that some effects may be observed at Earth late Day 1 (15 May) or on Day 2 (16 May). However, the preferred solution is for the CMEs to pass above the ecliptic plane as shown in the main deterministic run.

Solar wind speeds are currently at slightly elevated levels, around 460 km/s. In the absence of new CMEs, solar winds are expected to remain at slightly elevated levels, perhaps briefly crossing the threshold to elevated levels. A high latitude coronal hole (CH02/+) is not expected to provide an enhancement to solar winds, with its influence expected to pass above the ecliptic plane during the period. MOSWOC Enlil is considered to be giving reasonably good guidance with regard to wind strengths during the period.

Geomagnetic activity is expected to remain generally Quiet (Kp0-2) to Unsettled (Kp3), with a chance of Active (Kp4) periods from any minor influence from passing CMEs and a slight chance of an isolated G1/Minor Storm (Kp5) interval should a glancing blow arrive at Earth late Day 1 or Day 2 (15-16 May).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil expected. See main text for low confidence glancing impacts

Figure 2: MOSWOC Enlil (top) shows possible glancing blows from CMEs, but more likely to miss, which is the preferred scenario – also see Enlil Ensemble (bottom).

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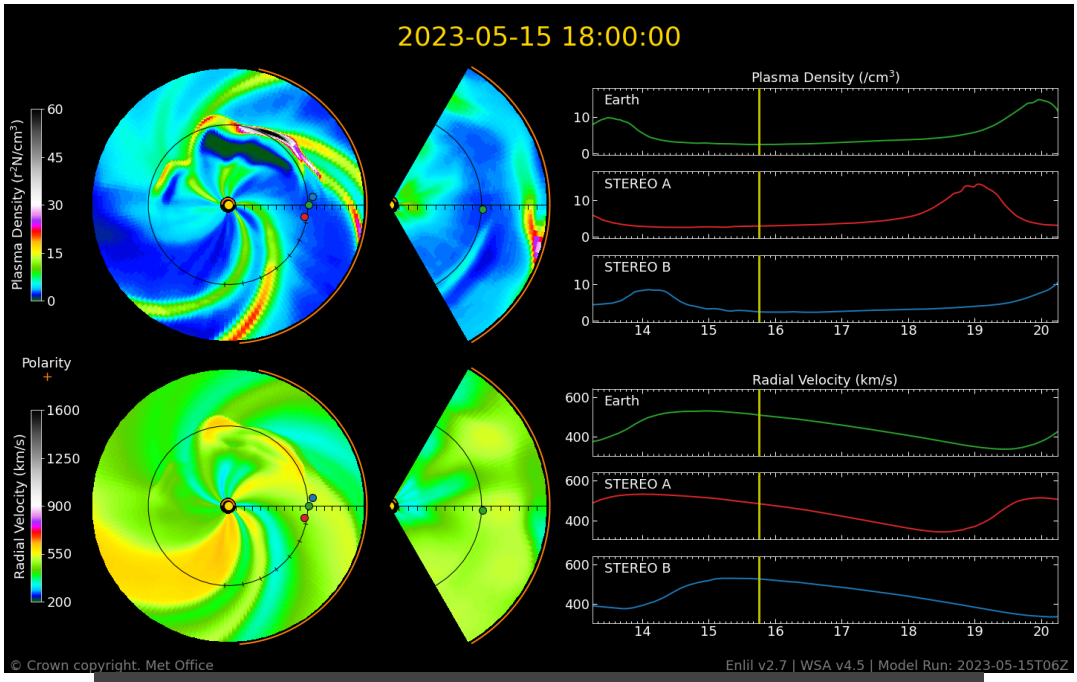

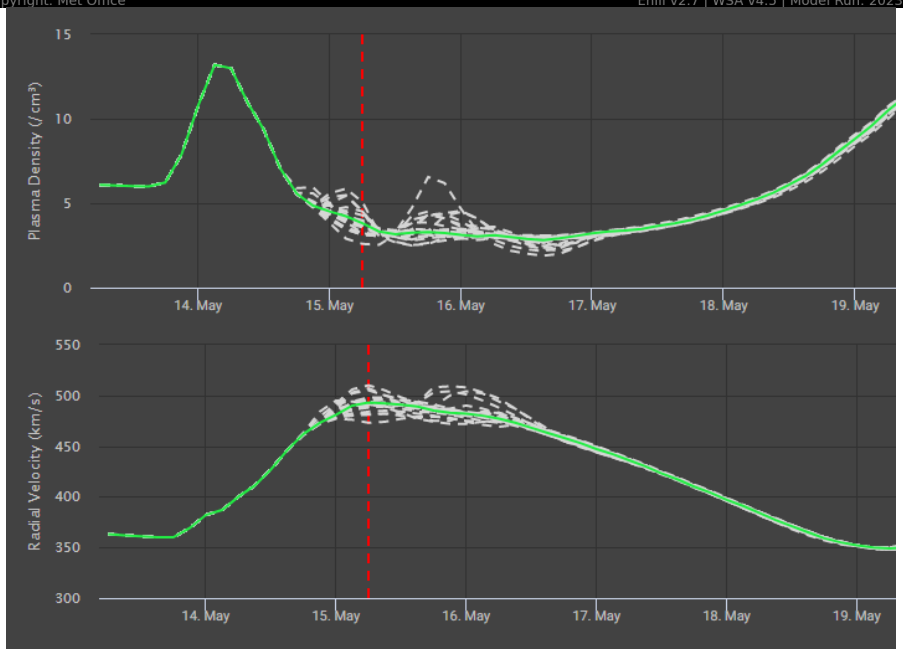

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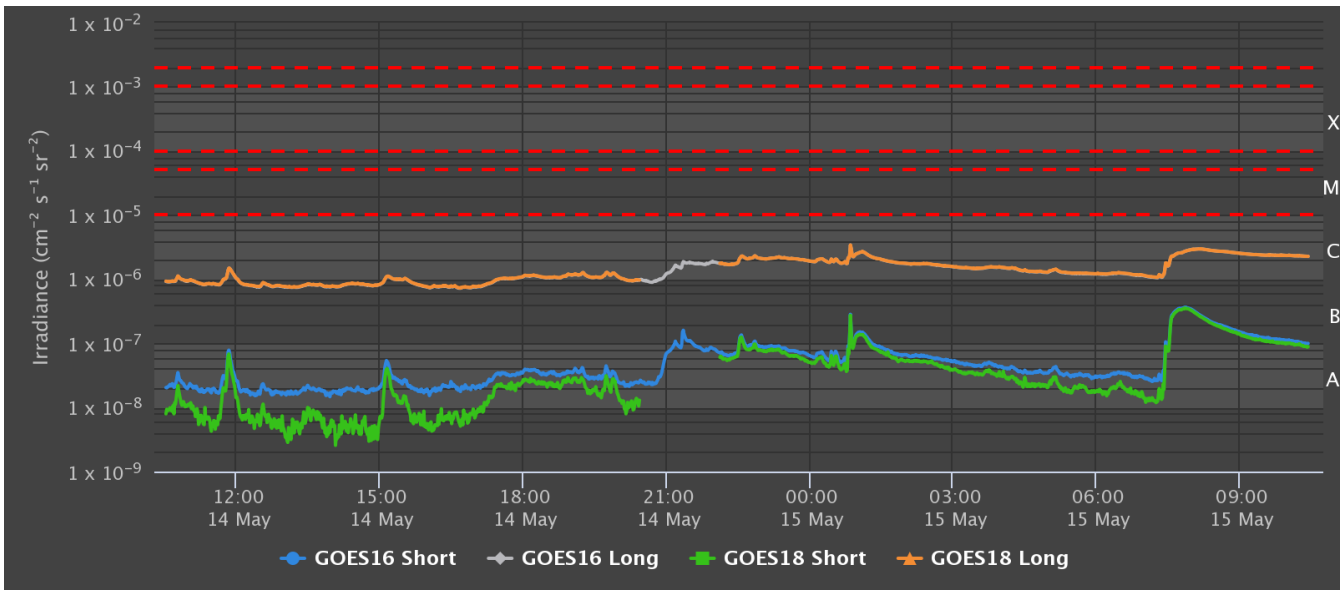
Radio Blackouts - X-Ray Flares:
There are currently six numbered regions on the visible disc. AR3305 remains the largest group, which has recently shown some slight growth in its trailing portion, although no recent flare activity has been observed from this region. AR3301 has developed a series of intermediate spots, but currently remains unipolar. The remaining areas are a mixture of unipolar and bipolar identities with little change noted. The sunspot in the southeast has been numbered AR3307 and is small and stable.

AR3296, presumed responsible for recent flare activity has now passed beyond the northwestern limb, but poses the risk for further isolated M-Class flares through Day 1 (15 May) before rotating beyond significant influence to Earth. AR3305 will gradually rotate into a more geoeffective position through the period and is the reason behind an uptick in M-class probabilities on Day 4 (18 May).

As stated, overall, the Sun seems to be entering an episodic lull in activity, with the Penticton 10.7cm flux falling from a midweek high of 180sfu on 09 May to 140sfu on 14 May. No new or returning sunspots are currently expected to rotate onto the disc during the period with the latest STEREO A EUVI 195 imagery not displaying any obvious signs of emerging sunspots. However, a relatively recent northeastern limb CME suggests that a region may yet be present that is approaching the eastern edge of the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	20	20	30
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-18 X-Ray flares



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16 has remained at Background levels throughout this 24-hour period. The most likely source for generating S1 events is AR3296, which has now rotated across the western limb, although still may pose a risk for an S1, although this risk will very gradually ease over the next few days.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	2	1	1
Very Active	≥ S3 *	No	1	1	1	1

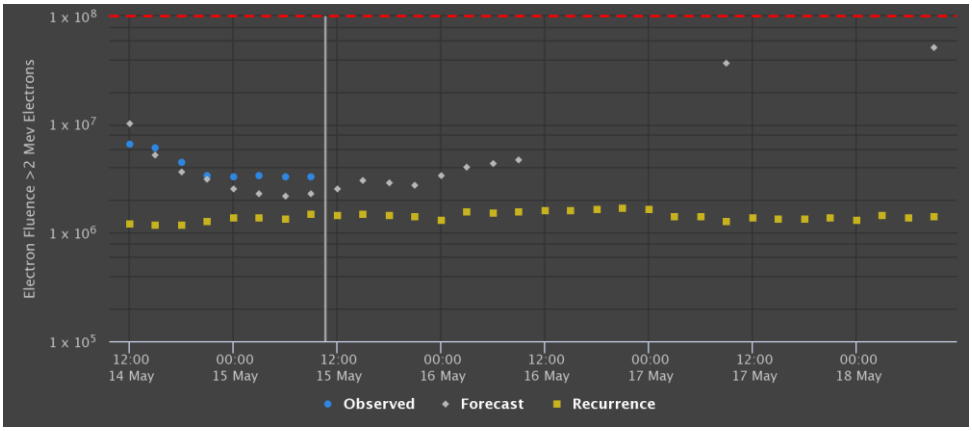
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has ranged from Moderate to Normal Background levels over the past 24 hours, as in the previous UTC day, implying a steady state has been reached. In the absence of significant solar wind speed enhancements, electron flux and fluence levels are forecast to remain below Active throughout. However, there remains some uncertainty towards the end of the period due to the potential interaction of glancing blows from CME on Earth's electron belts Days 1-2 (15-16 May).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	5	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM electron fluence – observations and forecast



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